CLAIMS

We claim:

1. A method comprising:

providing a substrate structure into a chamber of a first tool;

forming a barrier layer on the substrate structure;

forming a metal seed layer over the barrier layer;

performing in situ surface treatment of the substrate structure having the metal seed layer and the barrier layer thereon to form a passivation layer over the metal seed layer.

2. The method of claim 1 wherein in situ surface treatment is performed in a gas environment selected from the group consisting of inert gases, hydrogen gas, fluorine containing gas, forming gas, oxygen gas and nitrogen gas.

3. The method of claim 1 wherein in situ surface treatment is performed using a liquid selected from the group consisting of acids, bases, solvents and di-ionized water.

4. The method of claim 2 wherein in situ surface treatment is performed in an oxygen gas environment to form a metal oxide layer on the metal seed layer.

5. The method of claim 1 wherein the metal seed layer is selected from the group consisting of copper, copper alloy, nickel, silver, gold and cobalt.

6. The method of claim 1 wherein the barrier layer is selected from the group consisting of tantalum, tantalum nitride, titanium, titanium nitride, tungsten nitride, tungsten-tantalum and tantalum silicon nitride.

7. The method of claim 1 wherein the first tool is a metal-barrier seed deposition tool.

8. The method of claim 1 wherein performing in situ surface treatment comprises

filling the chamber of the first tool with a gas for a first specified period of time, and

cooling the substrate structure having the metal seed layer and the barrier layer thereon in the chamber at a specified temperature for a second specified period of time to form a passivation layer on the metal seed layer.

9. The method of claim 8 wherein the first specified period of time is in a range of approximately 15-25 seconds.

10. The method of claim 8 wherein the second specified period of time is in a range of approximately 5-15 seconds.

11. The method of claim 8 wherein the specified temperature is about 15-20° C.

12. The method of claim 8 wherein the gas comprises oxygen gas at a pressure of up to 2 torr.

13. The method of claim 1 further comprises providing the substrate structure with the barrier layer, metal seed layer and the passivation layer into a contamination removal chamber of an electroplating tool.

14. The method of claim 13 further comprises annealing the substrate in forming gas to reduce the passivation layer.

15. The method of claim 14 wherein annealing comprises flowing forming gas into the anneal chamber for a third specified period of time at a seed anneal temperature of about 250° C.

16. The method of claim 15 wherein annealing further comprises cooling the annealed substrate in forming gas for fourth specified period of time at a seed anneal cooling temperature of about 15-20° C.

17. The method of claim 15 wherein the third specified period of time is about 30 seconds.

18. The method of claim 16 wherein the fourth specified period of time is about 25 seconds.

19. The method of claim 14 wherein the forming gas comprises about 95 percent nitrogen and 5 percent hydrogen.

20. The method of claim 14 further comprises depositing a conductive material at least in a trench and a via patterned on the substrate using a plating method selected from the group of electrolytic plating and electroless plating.

21. The method of claim 20 wherein the conductive material is selected from the group consisting of copper, silver and gold.

22. A method comprising:

providing a substrate into an electroplating tool, the substrate having at least a trench and at least a via patterned thereon, a barrier layer formed in the trench and the via, a metal seed layer formed on the barrier layer and a passivation layer formed on the metal seed layer;

annealing the substrate in forming gas to reduce the passivation layer; and

depositing a conductive material at least inside the trench and the via of the substrate using a plating process selected from the group consisting of electrolytic plating and electroless plating.

23. The method of claim 22 wherein annealing and depositing are performed sequentially for each substrate in a substrate batch under vacuum conditions within the electroplating tool.

24. The method of claim 22 wherein annealing comprises flowing forming gas into a contamination removal chamber of the electroplating tool for a third specified period of time at a seed anneal temperature of about 250° C.

25. The method of claim 22 wherein annealing further comprises cooling the annealed substrate in forming gas for fourth specified period of time at a temperature of about 15-20° C.

26. The method of claim 24 wherein the third specified period of time is about 30 seconds.

27. The method of claim 25 wherein the fourth specified period of time is about 25 seconds.

28. A system comprising:

at least one contamination removal chamber to perform seed anneal of a substrate, the substrate having at least a trench and a via patterned thereon, a barrier layer formed in the trench and the via, a metal seed layer formed on the barrier layer, and a seed passivation layer formed on the metal seed layer;

a gas delivery system coupled to the at least one contamination removal chamber to introduce a forming gas into the contamination removal chamber to reduce the seed passivation layer; and

at least one plating chamber coupled to the at least one contamination removal chamber and to the gas delivery system, the at least one plating chamber for depositing a conductive material at least inside the trench and the via of the substrate using a plating process selected from the group consisting of electrolytic plating and electroless plating.

29. The system of claim 28 wherein performing seed anneal and depositing a conductive material are performed sequentially for each substrate in a substrate batch under vacuum conditions within the electroplating tool.

30. The system of claim 28 wherein the gas delivery system introduces into the contamination removal chamber hot forming gas at a third temperature of about 250°C for about 30 seconds followed by cool forming gas at a fourth temperature of about 20° C for about 25 seconds.